Original Article

Tooth Loss and Predictors of Tooth Extractions Due to Dental Caries among Adults: A Multi-center Study in North-eastern Nigeria

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Abstract

Background: Tooth loss and the level of edentulism may be an indication of a populations' oral health. The aim of this study was to evaluate the contribution of dental caries to tooth loss, as well as its predictors among adults in North-eastern Nigeria. **Methods:** A cross-sectional survey over a 2-month period of all adult patients who had tooth extractions in three dental centers across North-eastern Nigeria. Data on sociodemographics (age, gender, and level of education), history, and examination findings were collected with a preformed questionnaire to include the frequency and reasons for the use of dental facilities, previous tooth extractions and reason for extractions, missing teeth, and present diagnosis for the teeth to be extracted. Bivariate and multivariate analyses were used to determine the association and relationships between missing teeth, extractions due to caries and population variables. **Results:** The prevalence of preextraction tooth loss was 37.98% with a mean tooth loss of 3.05 ± 3.15 per participant, 2.24 ± 1.46 among the 35–44 years old and highest (10.08 ± 8.02) among the 65–74 years old participants. Age was the single significant predictor of tooth loss ($\beta = 0.428$, $P < 0.001$). Molars were the most extracted teeth, with 78.13% of all extractions due to caries and its sequelae. Significant correlations existed between age ($r = -0.144$, $P = < 0.001$), level of education ($r = -0.118$, $P = 0.004$), and extractions due to caries and its sequelae and were significant in the regression model. **Conclusion:** Caries and its sequelae were the major reasons for missing teeth as well as for current extractions. Molars were the teeth most affected. Age and level of education were the important determinants of extractions due to caries and its sequelae.

Keywords: Dental caries, edentulism, sequelae, tooth extractions, tooth loss

Introduction

A crude but useful method of measuring the dental status of the community is by assessing tooth mortality which is mainly a reflection of untreated dental caries and periodontal disease.[1] Tooth loss may also be due to the failure of endodontic treatment, fracture, planned orthodontic, and prosthetic treatment. In most populations, however, pattern and reasons for extractions are similar, with dental caries and periodontal disease being the most important reasons.[2] Conventionally, epidemiological data showed a high prevalence of dental caries in most industrialized countries, whereas low caries levels were observed in developing countries.[3,4] With the changing patterns of sugar consumption, improved oral hygiene, effective use of fluorides, and effective use of oral health services, significant improvement in oral health status and a decrease in the prevalence of caries have been noticed over time in the industrialized countries.[4-7] On the other hand, the trend is that of an increase in the prevalence of caries in the developing countries. This may be related to the increased consumption of cariogenic diet in the absence of an equal increase in oral health awareness and access to oral care.[4,5]

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Access this article online

Quick Response Code:

Website: www.njmonline.org

DOI: 10.4103/NJM.NJM_60_20

How to cite this article: Idon PI, Mohammed A, Abdulmanan Y, Sotunde OA, Yusuf J, Olalekan TO, *et al*. Tooth loss and predictors of tooth extractions due to dental caries among adults: A multi-center study in North-eastern Nigeria. Niger J Med 2020;29:279-85.

Submitted: 11-Nov-2019 **Revised:** 11-Mar-2020
Accepted: 26-Apr-2020 **Published:** 26-Jun-2020

The significance of this lies in the potential contribution to tooth loss of untreated dental caries or its sequelae in these populations. Several epidemiological studies have suggested caries and its sequelae as the foremost reasons for tooth loss in different populations.[2,8,9] Majority of dental pain results from the sequelae of dental caries. Caries on its own is painless but may become severe enough to lead to tooth structure destruction that warrants tooth extraction. The carious lesion can also progress through the dentine to infect the pulp and periapical area. Pain from the inflamed pulp (pulpitis) and periapical (apical periodontitis) tissues can be severe. The pulpal tissue may eventually become necrosed, and the periapical inflammation may also result in abscess formation. This pain plus possible tooth tissue loss from the carious lesion may lead to tooth extraction being chosen as an option of treatment.

Although it is generally agreed that dental caries is the leading cause of tooth extractions in most populations, other modifying factors may also influence the decision to extract teeth depending on population characteristics.[10] Sociodemographic (age, gender, and education) and socioeconomic differences, cultural beliefs, access to dental care and behavioural factors such as oral hygiene practices and oral health-seeking behavior have also influenced reasons for tooth extractions. Similarly, the reasons for the extraction of specific tooth types and frequency of their loss also differ among populations. The susceptibility of each tooth type to caries and other dental conditions and hence loss by extraction may be determined by the differences in anatomical features, eruption, and position in the arch.[2,10-12]

Whatever the reason for extraction and tooth type affected, the loss of the tooth is the final common outcome when preventive or conservative measures fail. Epidemiological data on the incidence and prevalence of tooth loss vary considerably, making comparisons between populations and countries difficult. It is agreed, however, that tooth loss leads to functional, esthetic, and social damage with impact on people's quality of life.[13] To assess the global burden of oral diseases among adults, the WHO has recommended two adult age groups, 34–45 years old and 65 and above, for epidemiological surveys to include dental caries, periodontal disease, and edentulism.[5] In addition, and in conjunction with the Federation Dentaire Internationale (FDI), the global goals included a 50% and 25% reduction in edentulousness among these two age groups, respectively.[4,5,14]

In view of the contribution of oral health to overall health and well-being, Madléna *et al*.[15] advocated for epidemiological surveys to provide data that can be used to determine the trend of oral diseases in the population, as well as for comparison with other populations. In Nigeria, Esan *et al*.[16] in a national pilot study reported different predominant reasons for tooth loss among the six regions. Information about the oral health status, especially on dental caries, tooth loss, and the factors contributing to it among adults of the north-eastern Nigerian population is scarce. The significance of this information will be its contribution to data on tooth loss, caries prevalence, as well as the contribution of untreated caries and its sequelae to tooth loss in the country. The aim of this study was therefore to evaluate tooth loss, untreated dental caries, and its contribution to tooth loss, as well as to determine the pattern and other reasons for dental extractions among adults in North-eastern Nigeria.

Methods

The cross-sectional survey study was carried out over a 2-month period from June 2, 2017, to July 31, 2017, in three dental centres, State Specialist Hospital Damaturu, Abubakar Tafawa Balewa Teaching Hospital Bauchi, and State Dental Hospital Maiduguri, located in three of the North-eastern states of Nigeria. The consent of the appropriate Research and Ethics Committee in each center was obtained before the study. Participants were volunteers, who had given informed, written consent and included all adult patients, 18 years and older, scheduled for tooth extraction, or the first-time attendees to be treated by tooth extraction. The minimum statistically required sample size of 376 for the study was calculated using the prevalence value for tooth loss due to dental caries of 47% from a similar previous study.[16]

The history and examinations were carried out by three calibrated dentists, one in each center. The intra- and inter-examiner calibrations were performed before data collection commenced. The calculation of inter-examiner agreement yielded a mean kappa value of 0.92. Data on sociodemographics (age, gender, and education), use of dental facilities (prior dental visits and the reason for visits), previous tooth extractions, and reason for extractions were collected as the part of the participant's history. Prior tooth loss was recorded as being due to caries if there was a history of cavity before extraction.

Clinical examinations and radiographic imaging were carried out to identify and diagnose teeth indicated for extraction. Examinations were carried out with a plane dental mirror and community periodontal index probe following the criteria set by the WHO for the diagnosis of dental caries.[17] The reason for extraction was recorded as caries, to include its sequels involving the pulp and the periradicular tissues; periodontal disease; orthodontic reason, as tooth indicated for extractions as part of orthodontic treatment planning; prosthodontic; trauma, as tooth extracted due to external trauma that rendered the tooth un-restorable; and others, to include impacted teeth and failed endodontic treatment. All information obtained from the participants were recorded into a questionnaire designed for the study.

Data analysis

The data collected were analyzed and tested for significance by the Statistical Package for the Social Sciences (SPSS) for Mackintosh (SPSS version 21, SPSS Inc., Chicago, IL, USA). Descriptive Statistics was used to determine the prevalence of tooth loss, dental caries, as well as the distribution of participants by centers, the reasons for extraction and tooth

type extracted. ANOVA and Chi-square tests were used to determine the association between the participants' variables and the prevalence of dental caries, and tooth loss at 95% confidence interval and level of statistical significance set at $P < 0.05$. Correlation analysis was carried out to determine the relationship between participants' variables and the number of missing teeth and extractions due to caries and its sequelae, while multiple regression statistics were used to estimate the relationships of the participants' variables to the number of missing teeth, and the number of teeth extracted due to caries.

Results

Prevalence of tooth loss

Six hundred and three participants with a mean age of 32.99 ± 12.25 (standard deviation), and a 1.1:1 male-to-female ratio attended for extractions in three government dental clinics across the Northeast during the 2-months study period. Fifty-seven percent (344) were first-time attenders, whereas 80.79% of those with missing teeth had prior visits to the dentist. Participants with secondary and tertiary education accounted for 47.43% and 23.52%, respectively. Two hundred and twenty-nine (37.98%) of the participants had a total of 669 missing teeth that ranged from 1 to 26 teeth, with a mean number of 3.05 ± 3.15 per participant. The mean number of missing teeth ranged from 2.24 ± 1.46 among the 35–44 year old to 10.08 ± 8.02 in the 65–74 years old participants. Four hundred and sixty-two (66.10%) of the missing teeth were lost due to caries. The majority (78.60%) of those with missing teeth had less than tertiary education. Age was significantly ($r = 0.392$, $P = < 0.001$) correlated with the number of missing teeth, and the association was positive. This indicates that the number of missing teeth increased with age. Correlations were very weak and insignificant for gender, level of education, and prior dental visits. In multiple regression analysis, these variables statistically significantly predicted the number of missing teeth, F (4, 224) =11.363, $P < 0.005$, $R^2 = 0.169$, $R = 0.411$. Age had a positive significant regression weight (β =0.428, $P = < 0.001$). None of the other variables contributed to the regression model. Table 1 shows the distribution of the remaining dentition among the participants by their age group and gender.

Caries prevalence

A total of 1117 carious lesions were recorded in 511 (84.74%) of the participants, with a range of 1–12 and a mean of 2.19 ± 1.61 carious lesions. The highest prevalence of caries (90.34%) was noted in the 25–34 year age group, whereas 88.46% and 25% of the 35–44 and 65–74 years old participants presented with carious lesions, respectively. Differences were noted in the number and mean carious teeth by participant variables but with no statistical significance except for gender [Table 2].

Reasons for extractions

Seven hundred and fifty extractions were carried out among the 603 participants, a mean of 1.24 ± 0.57 per participant. The 25–34 and those in the ≤24 year age groups were the predominant groups that had extractions done, with 256 and 239 teeth extracted, respectively. Majority of the extractions (78.13%) were due to caries and its sequelae [Table 3], with the highest number of extractions (34.13%) carried out among the 25–34 years age group. The proportion of extractions due to caries and its sequelae, 83.68%, 85.16%, 85.94%, 55.56%, 38.89% and 21.05%, decreased with increasing age. Periodontal disease was the second most frequent reason for extraction (9.60%) and accounted for the highest proportion of extractions among the 55–64 (44.44%) and the 65–74 year (47.37%) age groups. Trauma, the third single most common cause of extraction was most common among those ≤24 years. The highest proportions, 78.74% and 77.51%, of the extractions, were due to caries and its sequelae among the males and females, respectively. Furthermore, 83.33%, 79.53% 67.78%, 70.06%, and 84.98% represented the proportion of extractions due to caries for participants with no formal education, secondary education, tertiary education, and those with and without prior dental visits, respectively.

The result showed a weak negative but significant correlation between age ($r = -0.144$, $P < 0.001$), level of education ($r = -0.118$, $P = 0.004$), and teeth extractions due to caries. In multiple regression, all the variables (age, level of education, gender, and prior dental visits) significantly predicted the number of extractions due to caries, F (4, 598) =6.040, $P < 0.0005$, $R^2 = 0.039$. Age (β = −0.160, $P < 0.001$) and level of education (β = −0.131, $P = 0.001$) had negative significant regression weights indicating the decreased number of teeth extracted due to caries with increasing age and level of education. Only these two variables contributed to the regression model, $P < 0.05$. $R = 0.197$.

The lower molars were the most extracted teeth (397, 52.93%), followed by the upper molars (192, 25.60%), the upper premolars (62, 8.26%), and the upper incisors (46, 6.14%). Among these, the lower first molar was the single most extracted tooth (22.93%) [Table 4]. Extractions were more in the mandible (58.80%), and posterior teeth were extracted more (91.20%) than the anterior in both arches. Caries and its sequelae accounted for the majority of extractions related to the molars (85.57%) and premolars (82.11%). About half (51.85%) of the extracted incisors were due to periodontal disease, whereas 40.74% were due to trauma. Most of the upper incisors (45.65%) were extracted due to trauma, whereas 87.50% of the extracted lower incisors were due to periodontal disease.

Discussion

Epidemiological data on dental health from the northern part of the country are scarce. The present study was conducted to explore the prevalence of tooth loss and dental caries in the north-eastern region, and the proportion of these extractions that are due to caries among adult patients – as a measure of the level of caries prevention and/or treatment among

Table 1: Distribution of participants' remaining dentition by age group and gender

Age group	Gender	Teeth present, *n* (%)			
		21 or more	<21	<5	Total
≤24	Male	109 (53.43)	0	0	109 (53.43)
	Female	95 (46.57)	0	0	95 (46.57)
	All	204 (100.0)	0	0	204 (100.0)
25-34	Male	113 (54.60)	0	0	113 (54.60)
	Female	93 (44.93)	1 (0.48)	0	94 (45.41)
	All	206 (99.53)	1 (0.48)	0	207 (100.0)
35-44	Male	50 (48.08)	0	0	50 (48.08)
	Female	54 (51.92)	0	0	54 (51.92)
	All	104 (100.00)	0	0	104 (100.0)
45-54	Male	26 (49.06)	1 (1.89)	0	27 (50.95)
	Female	26 (49.06)	0	0	26 (49.06)
	All	52 (98.12)	1 (1.89)	0	53 (100.0)
55-64	Male	13 (56.52)	0	0	13 (56.52)
	Female	10 (43.48)	0	0	10 (43.48)
	All	23 (100.00)	0	0	23 (100.0)
65-74	Male	1 (8.33)	2 (16.67)	2 (16.67)	5 (41.67)
	Female	7 (58.33)	0	0	7 (58.33)
	All	8 (66.67)	2 (16.67)	2 (16.67)	12 (100.00)
Total		597 (99.00)	4 (0.66)	2 (0.33)	603 (100.00)

Table 2: Distribution of patients and carious teeth by age, gender and prior dental visit

Variable	Patients, *n* (%)	Carious teeth, *n* (%)	Mean carious teeth±SD	*P*
Age group (years)				
≤24	177 (34.64)	374 (33.48)	2.11±1.46	0.617
25-34	187 (36.59)	438 (39.21)	2.34±1.76	
35-44	92 (18.00)	202 (18.08)	2.20±1.48	
45-54	38 (7.44)	71 (6.36)	1.87±1.77	
55-64	14 (2.74)	28 (2.51)	2.00±1.80	
65-74	3 (0.59)	4 (0.36)	1.33±0.58	
Gender				
Male	266 (50.05)	529 (47.36)	1.99±1.34	0.044
Female	245 (47.95)	588 (52.64)	2.40±1.84	
Level of education				
No formal education	154 (30.14)	346 (30.98)	2.25±1.82	0.303
Secondary school and below	247 (48.34)	558 (49.96)	2.26±1.59	
Tertiary	110 (21.53)	213 (19.07)	1.94±1.29	
Prior dental visits				
Yes	205 (40.12)	471 (42.17)	2.30±1.65	0.556
No	306 (59.88)	646 (57.83)	2.11±1.58	
Total	511 (100)	1117 (100)	1.85±1.68	

SD: Standard deviation

adults in the region. Caries is usually perceived as a disease of childhood, but the relatively high prevalence of caries in this study (84.74%) showed that caries in adults were more prevalent than had been previously reported in other parts of the country in children and adolescents,[18,19] as well as adults.[20,21] Although statistically insignificant, but expected, the caries experience was observed to decrease with increasing age and was noted to be higher among the younger adults (25–34 and 35–44 years olds), females, and those without tertiary education, and lowest among the 65–74 years old. Surprisingly, however, though not significant, participants with previous dental visits had a higher mean number of carious teeth compared to first-time clinic attenders. This may be due to problem or pain-based dental attendance among these individuals, the cost of restorative treatment versus extractions and nonadherence to caries preventive measures.

Tooth loss, however, does not occur only as a result of dental caries but also due to several oral conditions. Thus, the level of edentulism has been seen as an indicator of a populations'

Table 3: Distribution of reasons for tooth extraction

Variable	Prosthetics, *n* (%)	Caries and its sequelae, *n* (%)	Orthodontic, *n* (%)	Trauma, *n* (%)	Periodontal, *n* (%)	Others, *n* (%)	Total
Age group (years)							
≤24	3 (0.40)	200 (26.67)	7 (0.93)	15 (2.00)	3 (0.40)	11 (1.47)	239 (31.87)
25-34	1 (0.13)	218 (29.07)	2 (0.27)	4 (0.53)	13 (1.73)	18 (2.40)	256 (34.13)
35-44	1 (0.13)	110 (0.15)	0	2 (0.27)	6 (0.80)	9 (1.20)	128 (17.07)
45-54	1 (0.13)	40 (5.33)	0	5 (0.67)	25 (3.33)	1 (0.13)	72 (9.60)
55-64	0	14 (1.87)	0	3 (0.40)	16 (2.13)	3 (0.40)	36 (4.80)
65-74	5 (0.67)	4 (0.53)	0	0	9 (1.20)	1 (0.13)	19 (2.53)
Gender							
Male	5 (0.67)	300 (40.00)	4 (0.53)	17 (2.27)	35 (4.67)	20 (2.67)	381 (50.80)
Female	6 (0.80)	286 (38.13)	5 (0.67)	12 (1.60)	37 (4.93)	23 (3.07)	369 (49.20)
Level of education							
No formal education	3 (0.40)	190 (25.33)	0	5 (0.67)	28 (3.73)	2 (0.27)	228 (30.40)
Secondary school and below	6 (0.80)	272 (36.27)	6 (0.80)	12 (1.60)	27 (3.60)	19 (2.53)	342 (45.60)
Tertiary	2 (0.27)	122 (16.27)	3 (0.40)	12 (1.60)	17 (2.27)	22 (2.93)	180 (24.00)
Prior dental visits							
Yes	6 (0.80)	241 (32.13)	3 (0.40)	6 (0.80)	53 (7.07)	35 (4.67)	344 (45.87)
No	5 (0.67)	345 (46.00)	6 (0.80)	23 (3.07)	19 (2.53)	8 (1.07)	406 (54.13)
Total	11 (1.47)	586 (78.13)	9 (1.20)	29 (3.87)	72 (9.60)	43 (5.73)	750 (100)

Table 4: Distribution of type of tooth extracted versus reasons for extraction

Tooth type	Prosthetics, *n* (%)	Caries and its sequelae, *n* (%)	Orthodontic, *n* (%)	Trauma, *n* (%)	Periodontal, *n* (%)	Others, *n* (%)	Total
Upper central incisor	0	3 (0.40)	0	17 (2.27)	17 (2.27)	1 (0.13)	38 (5.07)
Upper lateral incisor	0	1 (0.13)	0	4 (0.53)	3 (0.40)	0	8 (1.07)
Upper canine	0	0	0	1 (0.13)	0	0	1 (0.13)
Upper first premolar	1 (0.13)	16 (2.13)	8 (1.07)	1 (0.13)	0	4 (0.53)	30 (4.00)
Upper second premolar	0	35 (4.67)	0	0	2 (0.27)	3 (0.40)	40 (5.33)
Upper first molar	1 (0.13)	76 (10.13)	0	1 (0.13)	9 (1.20)	6 (0.80)	93 (12.40)
Upper second molar	1 (0.13)	35 (4.67)	0	0	6 (0.80)	0	42 (5.60)
Upper third molar	3 (0.40)	44 (5.87)	0	0	7 (0.93)	3 (0.40)	57 (7.60)
Lower central incisor	0	0	0	0	4 (0.53)	0	4 (0.53)
Lower lateral incisor	0	0	0	1 (0.13)	3 (0.40)	0	4 (0.53)
Lower canine	0	0	0	0	0	0	
Lower first premolar	0	7 (0.93)	0	0	1 (0.13)	0	8 (1.07)
Lower second premolar	0	20 (2.67)	0	1 (0.13)	2 (0.27)	2 (0.27)	25 (3.33)
Lower first molar	0	159 (21.20)	0	0	8 (1.07)	5 (0.67)	172 (22.93)
Lower second molar	1 (0.13)	121 (16.13)	0	1 (0.13)	5 (0.67)	1 (0.13)	129 (17.20)
Lower third molar	4 (0.53)	69 (9.2)	0	2 (0.27)	5 (0.67)	16 (2.13)	96 (12.80)
Deciduous teeth	0	0	1 (0.13)	0	0	2 (0.27)	3 (0.40)
Total	11 (1.47)	586 (78.13)	9 (1.20)	29 (3.87)	72 (9.60)	43 (5.73)	750 (100)

oral health. The prevalence of tooth loss in the population studied was 37.98%, with a mean number of missing teeth that is lower than most reported figures,[10,22,23] higher than that reported by Begum *et al*.,[24] but similar to that observed among Sudanese adults.[25] None of the participants were completely edentulous, and 99% of them had ≥21 natural teeth present. This figure is, however, skewed in favor of the younger adults in the study. All the participants in the 35–44 years age group had ≥21 natural teeth present, whereas it was 66.67% for the 65–74 years age group. Although encouraging, there is no baseline data for these age groups for comparison to assess the trend in line with the FDI and WHO goals.[5,14] Compared to the mean tooth loss of 10.08 teeth among the participants aged 65–74 years in this study, studies among Tanzanians and Brazilians have reported 5.9 and 18.1 mean tooth loss in similar age groups in their populations.[10,26]

The emphasis on the two age groups, 35–44 and 65–74, is due to the WHO's recommendations that the oral health of these two groups is important in describing the cumulative damage of dental caries, periodontal diseases as well as the effect of oral health services on the population over the years.[26,27]

Although not directly comparable but in contrast to the present study, another study conducted in the south-west region of the country reported a 1.3% prevalence of edentulism among people older than 65 years.[28] The result from the present study may however be an overestimation of the teeth present as this data were recorded before the planned extractions. Despite this, and with the observed teeth present among this population, the teeth present is in line with the WHO dentition status criteria as well as the FDI recommendation of greater or equal to 20 teeth present in people older than 65 years.[14] This is consistent with the observations from other African studies,[25,26,29,30] but in contrast to studies carried out in the developed countries that showed higher rates of edentulism among older-aged individuals.[15,31,32] This trend is however declining as there is a decrease in edentulism in new adult cohorts studied in several developed countries.[28] Similar to the findings by Khalifa *et al*. among Sudanese adults,[25] participants with prior visits to the dentist accounted for a major proportion of those with missing teeth. Aside from the higher dental caries experience and use of dental care services, the reasons for this finding may be related to dental visits being mainly problem-based, and to lack of information for the patients from the dentists about conservative procedures and preventive approaches, or to patients' request for extractions which in most situations is cheaper than conservative or endodontic procedures.

Supported by several studies[2,8,9,26,33-35] caries and its sequelae were found to be the most common reason for tooth extraction among the participants in the present study, followed by periodontal disease. Previous studies, including one in Nigeria, had however reported periodontal diseases as the major reason for tooth loss.[8,36,37] With the increasing trend in caries prevalence in the country,[38,39] there thus seems to be a progression of reasons for tooth loss from predominantly periodontal[36] to dental caries over the years. This is supported by the increase from 47% as reported for the Northeast by Esan *et al.*[16] to the 78% reported in this study as the proportions of extractions due to caries and its sequelae. In contrast, the trend in the developed countries is a significant and progressive reduction in the rate of dental caries and tooth loss due to it.[31,34,35] The use of extraction as the main form of treatment for dental caries and its sequelae is probably why this trend has not been reported in this environment and other developing countries. Khalifa *et al*.,[25] suggested that the training of dentists, lack of awareness by the patient to seek early treatment for caries, and economic barriers to conservative dental care in the developing countries may be responsible for this. The high prevalence of caries among this population over that found in other parts of the country and the increase in the proportion of teeth extracted due to caries in comparison to previous independent studies in the country suggest that little has been done in terms of preventive and treatment programs designed to address this problem.

The significant negative correlation between age and number of extractions due to caries observed in this study indicates that this reason for tooth loss is age-related with an indirect relationship between the two. Dental caries and its sequelae accounted for the majority of extractions among the younger age groups and decreased with increasing age with periodontal disease accounting for most extractions in participants over 55 years of age. The highest number of caries, extraction due to caries, and total extractions carried out were seen in the 25–34-year-old participants. About 86% of teeth extracted among participants in the 35–44-year-old age range was due to caries and its sequelae against 21.10% among the 65–74 years old. There was little or no difference in the proportion of teeth extracted due to caries between the genders, but noticeable differences between the participants with tertiary education and below, as well as those with and without prior dental visits. As suggested[25,40] and supported by our findings, people without higher formal education are more likely to lose their teeth due to caries. Lack of awareness among this group of people may be a major contributing factor. Although not significant as a predictor from the regression model, the lower proportion of extractions due to caries among participants with prior dental visits may be due to increasing awareness about preventive measures for dental caries, a result of their earlier visits. Since the regression model also shows that only 3.9% of the variations in the number of teeth extracted due to caries can be accounted for by the variables studied, it suggests that important characteristics of individuals having extractions done as a result of caries and its sequelae were not present in the analysis.

The most extracted teeth were the molars, predominantly the lower molars, with the first molars and the lower ones as the single most extracted teeth. A significant majority of these molars, in the same order as above, and premolars were extracted due to caries and its sequelae. This sequence has been reported in other studies with several reasons suggested for it:[2,10-12,16] morphological reasons since the mandibular molars have more extensive pits and fissures; direct secretions from the parotid gland duct close to the maxillary teeth, thus reducing the pH around the maxillary molars in comparison to the lower ones; and the first molars being the first permanent teeth to erupt in the oral cavity.[12] As reported,[41] and supported by this study and others,[2,10-12] the early loss of the first permanent molars may be associated with increased caries experience on the occlusal surfaces of the second molars and premolars resulting in subsequent extractions.

Conclusion

It was determined that the prevalence of caries was high with a significant proportion of past tooth loss and present extractions identified to be due to caries and its sequelae, a preventable cause. Younger adults with little or no formal education, and without prior dental visits were more likely to have extractions due to caries. Older age, previous dental visits and lower than tertiary education were factors associated with an increased number of missing teeth. The observed difference in caries prevalence of the adult population in this study and that from the other parts of the country may suggest the need to develop

and implement oral health policies that consider the differences in characteristics of populations. Therefore, there is a need to carry out national surveys, especially prospective cohort studies on caries and tooth loss among adults to determine the trend, especially among specific adult age groups, as a basis for strategies that will promote long-term oral health and retention of healthy teeth throughout adulthood.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Farsi JM. Common causes of extraction of teeth in Saudi Arabia. Saudi Dent J 1992;4:101-5.
2. Ong G, Yeo JF, Bhole S. A survey of reasons for extraction of permanent teeth in Singapore. Community Dent Oral Epidemiol 1996;24:124-7.
3. Marthaler T. Changes in dental caries. 1953-2003. Caries Res 2004;38:173-81.
4. Petersen PE, Bourgeois D, Ogawa H, Estupinan-Day S, Ndiaye C. The global burden of oral diseases and risks to oral health. Bull World Health Organ 2005;83:661-9.
5. Brown LJ, Wall TP, Lazar V. Trends in caries among adults 18 to 45 years old. J Am Dent Assoc 2002;133:827-34.
6. Downer MC. Caries prevalence in the United Kingdom. Int Dent J 1994;44 Suppl 1:365-70.
7. von der Fehr FR. Caries prevalence in the Nordic countries. Int Dent J 1994;44:371-8.
8. Murray H, Locker D, Kay EJ. Patterns of and reasons for tooth extractions in general dental practice in Ontario, Canada. Community Dent Oral Epidemiol 1996;24:196-200.
9. Richards W, Ameen J, Coll AM, Higgs G. Reasons for tooth extraction in four general dental practices in South Wales. Br Dent J 2005;198:275-8.
10. Susin C, Oppermann RV, Haugejorden O, Albandar JM. Tooth loss and associated risk indicators in an adult urban population from south Brazil. Acta Odontol Scand 2005;63:85-93.
11. Baelum V, Fejerskov O. Tooth loss as related to dental caries and periodontal breakdown in adult Tanzanians. Community Dent Oral Epidemiol 1986;14:353-7.
12. Chukwu GA, Adeleke OA, Danfillo IS, Otoh EC. Dental caries and extractions of permanent teeth in Jos, Nigeria. Afr J Oral Health 2004;1:31-6.
13. Batista MJ, Lawrence HP, de Sousa Mda L. Impact of tooth loss related to number and position on oral health quality of life among adults. Health Qual Life Outcomes 2014;12:165.
14. Federation Dentaire Internationale/World Health Organization. Global goals for oral health in the year 2000. Int Dent J 1982;32:74-7.
15. Madléna M, Hermann P, Jáhn M, Fejérdy P. Caries prevalence and tooth loss in Hungarian adult population: Results of a national survey. BMC Public Health 2008;8:364.
16. Esan TA, Olusile AO, Ojo MA, Udoye CI, Oziegbe EO, Olasoji HO. Tooth loss among Nigerians treated in teaching hospitals: A national pilot study. J Contemp Dent Pract 2010;11:017-24.
17. World Health Organization. Oral Health Survey: Basic Methods. 4th ed. Geneva: World Health Organization; 1997.
18. Soroye MO, Braimoh BO. Oral health practices and associated caries experience among secondary school students in Lagos State, Nigeria. J Oral Res Rev 2017;9:16-20.
19. Braimoh OB, Umanah AU, Ilochonwu NA. Caries distribution, prevalence, and treatment needs among 12–15-year-old secondary school students in port harcourt, Rivers State, Nigeria. J Dent Surg 2014:483760:1-6. [doi.org/10.1155/2014/483760].
20. Olabisi AA, Udo UA, Ehimen UG, Bashiru BO, Gbenga OO, Adeniyi AO. Prevalence of dental caries and oral hygiene status of a screened population in port harcourt, Rivers State, Nigeria. J Int Soc Prev Community Dent 2015;5:59-63.
21. Omitola OG, Arigbede AO. Prevalence of dental caries among adult patients attending a tertiary dental institution in South-South region of Nigeria. Port Harcourt Med J 2012;6:52-8.
22. Wu B, Hybels C, Liang J, Landerman L, Plassman B. Social stratification and tooth loss among middle-aged and older Americans from 1988 to 2004. Community Dent Oral Epidemiol 2014;42:495-502.
23. Urzua I, Mendoza C, Arteaga O, Rodrı´guez G, Cabello R, Faleiros S, *et al*. Dental caries prevalence and tooth loss in chilean adult population: First National Dental Examination Survey. Int J Dent 2012;2012:1-6.
24. Begum SK, Reddy VC, Kumar RK, Sudhir KM, Srinivasulu G, Ali SK. Tooth loss prevalence and risk indicators among adult people visiting community health centres in Nellore district, Andhra Pradesh: A cross-sectional study. J Indian Assoc Public Health Dent 2016;14:413-8.
25. Khalifa N, Allen PF, Abu-Bakr NH, Abdel-Rahman ME. Factors associated with tooth loss and prosthodontic status among Sudanese adults. J Oral Sci 2012;54:303-12.
26. Kida IA, Åstrøm AN, Strand GV, Masalu JR. Clinical and socio-behavioural correlates of tooth loss: A study of older adults in Tanzania. BMC Oral Health 2006;6:5.
27. Petersen PE, Bourgeois D, Bratthall D, Ogawa H. Oral health information systems – Towards measuring progress in oral health promotion and disease prevention. Bull World Health Organ 2005;83:686-93.
28. Taiwo JO, Omokhodion F. Pattern of tooth loss in an elderly population from Ibadan, Nigeria. Gerodontology 2006;23:117-22.
29. Petersen PE, Razanamihaja N. Oral health status of children and adults in Madagascar. Int Dent J 1996;46:41-7.
30. Petersen PE, Kaka M. Oral health status of children and adults in the Republic of Niger, Africa. Int Dent J 1999;49:159-64.
31. Dye BA, Thornton-Evans G, Li X, Iafolla TJ. Dental Caries and Tooth Loss in Adults in the United States, 2011–2012, NCHS Data Brief, no 197. Hyattsville, MD: National Center for Health Statistics; 2015.
32. Slade GD, Spencer AJ, Roberts-Thomson K. Tooth loss and chewing capacity among older adults in Adelaide. Aust N Z J Public Health 1996;20:76-82.
33. Aida J, Ando Y, Akhter R, Aoyama H, Masui M, Morita M. Reasons for permanent tooth extractions in Japan. J Epidemiol 2006;16:214-9.
34. Cleaton-Jones P, Fatti P. Dental caries trends in Africa. Community Dent Oral Epidemiol 1999;27:316-20.
35. Haseeb M, Ali K, Munir MF. Causes of tooth extraction at a tertiary care centre in Pakistan. J Pak Med Assoc 2012;62:812-5.
36. Odusanya SA. Tooth loss among Nigerians: Causes and pattern of mortality. Int J Oral Maxillofac Surg 1987;16:184-9.
37. Reich E, Hiller KA. Reasons for tooth extraction in the western states of Germany. Community Dent Oral Epidemiol 1993;21:379-83.
38. Sheiham A. The prevalence of dental caries in the Nigerian population. Br Dent J 1967;123:144-8.
39. Henshaw NE. A survey of dental caries and oral hygiene in the southern zone of Nigeria. Nig Med J 1974;4:185-96.
40. Eklund SA, Burt BA. Risk factors for total tooth loss in the United States; longitudinal analysis of national data. J Public Health Dent 1994;54:5-14.
41. Oliver RG, Oliver SJ, Dummer PM, Hicks R, Kingdon A, Addy M, *et al*. Loss of the first permanent molar and caries experience of adjacent teeth. Community Dent Health 1992;9:225-33.